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HABITAT PREFERENCES OF CARRION BEETLES IN THE GREAT SWAMP NATIONAL WILDLIFE REFUGE, NEW JERSEY (COLEOPTERA: SILPHIDAE, DERMESTIDAE, NITIDULIDAE, HISTERIDAE, SCARABAEIDAE)

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Abstract.—A total of 2,397 individuals representing 8 species of carrion beetles (Silphidae) and 2,336 individuals representing 4 species of "carrion beetles" from 4 other families were collected on carrion in the Great Swamp National Wildlife Refuge during June, July and August in 1980 and during April and May in 1981. Beetles were trapped in 3 habitats—forest, field, and marsh. Of the 8 silphid species, 5 manifested a *strong preference* for a given habitat. These species were *Oiceoptoma noveboracense* (forest), *Necrophila americana* (field), *Nicrophorus orbicollis* (forest), *Nicrophorus pustulatus* (forest), and *Necrodes surinamensis* (forest). Two silphid species manifested a *slight preference* for a given habitat: *Oiceoptoma inaequale* (field), and *Nicrophorus tomentosus* (field). One species, *Nicrophorus marginatus,* manifested a *probable preference* for the field. Insofar as other "carrion beetles" are concerned, 1 species, *Onthophagus hecate* (Scarabaeidae) showed a *strong preference* for the field. Three species manifested *slight preferences* for given habitats: *Omosita colon* (Nitidulidae) and *Dermestes caninus* (Dermestidae) for the forest, and *Euspilotus assimilis* (Histeridae) for the field.

A search of the literature on carrion beetles indicates that there has been increased interest and research on this group of beetles during the past quarter century. Many of the papers that have appeared have dealt with the ecology and behavior of species of the taxon. Conspicuous, however, has been the lack of information on the habitat preferences of these beetles. In the 2 papers that have mentioned habitat preferences, Walker (1957) tabulated arthropod species that were attracted to carrion-baited pitfall traps in 4 habitats—mesic forest, bottom forest, ridge forest and old field and Anderson (1982) studied Silphidae that were collected in carrion-baited pitfall traps in 4 very distinct habitats—deciduous forest, coniferous forest, field/meadow, and marsh.

In a recent study to determine the species composition and seasonal abundance of carrion beetles in an oak-beech forest in the Great Swamp National Wildlife Refuge (GSNWR), Basking Ridge, New Jersey, 7 species of Silphidae were present (Shubeck et al., 1981). Over 98% of these silphids were taken from early April through August. *Oiceoptoma noveboracense* was very

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abundant from April through July with a peak in May. *Necrophila americana* was most active from May through August with a pronounced peak in July. *Oiceoptoma inaequale* was an early season silphid, being most active from April through June, with a peak of activity in April. *Nicrophorus orbicollis* was active from May through September and peaked in August. Although *Necrodes surinamensis* was active from June through September over ⅔ of the individuals were taken in August. *Nicrophorus pustulatus* was collected in May and into September with over ½ of the season's catch taken in June. *Nicrophorus tomentosus* was taken from June through October but almost ½ of these individuals were collected in August. Among the 55 additional taxa also present were 4 very abundant species from other beetle families (Nitidulidae, Histeridae, Dermestidae, Scarabaeidae).

For this study it was decided that additional information about the carrion beetles of GSNWR might be obtained by collecting and comparing the numbers of carrion beetles in the 3 distinct habitats found in this refuge—forest (deciduous), field, marsh. The species of carrion beetles included in this study were: *all* species of Silphidae, *Dermestes caninus* (Dermestidae), *Omosita colon* (Nitidulidae), *Euspilotus assimilis* (Histeridae), and *Onthophagus hecate* (Scarabaeidae).

MATERIALS AND METHODS

Carrion beetles were trapped in 6 No. 10 food cans (3.78 liter), each of which was concealed in a wooden box having 1.27 cm wire mesh at the top and a rain cover 5 cm above the opening. These traps have been described elsewhere (Shubeck, 1976). Two traps, 10 meters apart, were placed on the ground in a red oak forest about 2 km northeast of the former refuge headquarters building. Two traps, also 10 meters apart, were placed on the ground in an old field adjacent to the forest. This field collecting station was about ½ km northeast of the forest collecting station and about 100 meters from the edge of the forest. Two traps, 10 meters apart, were individually mounted on stakes that had been driven into the mud of a marsh adjacent to the field. The marsh collecting station was about 400 meters east of the field collecting station but only 5 meters into the marsh. I would have preferred to situate the traps farther into the marsh but this was not possible because of the very soft ooze (mud) and about 20 cm of water covering the mud from April through July. The difference in distance (field traps situated 100 meters from edge of forest and marsh traps situated 5 meters from the edge of field) was not considered a problem because a previous study had shown that the return to baited traps by carrion beetles released at 5 to 75 meters was a result of random wandering (Shubeck, 1968). The same study showed that the periphery of odor perception seems to be about 1 meter from carrion. Given this information it seemed improbable that baited traps would attract beetles from adjacent habitats.

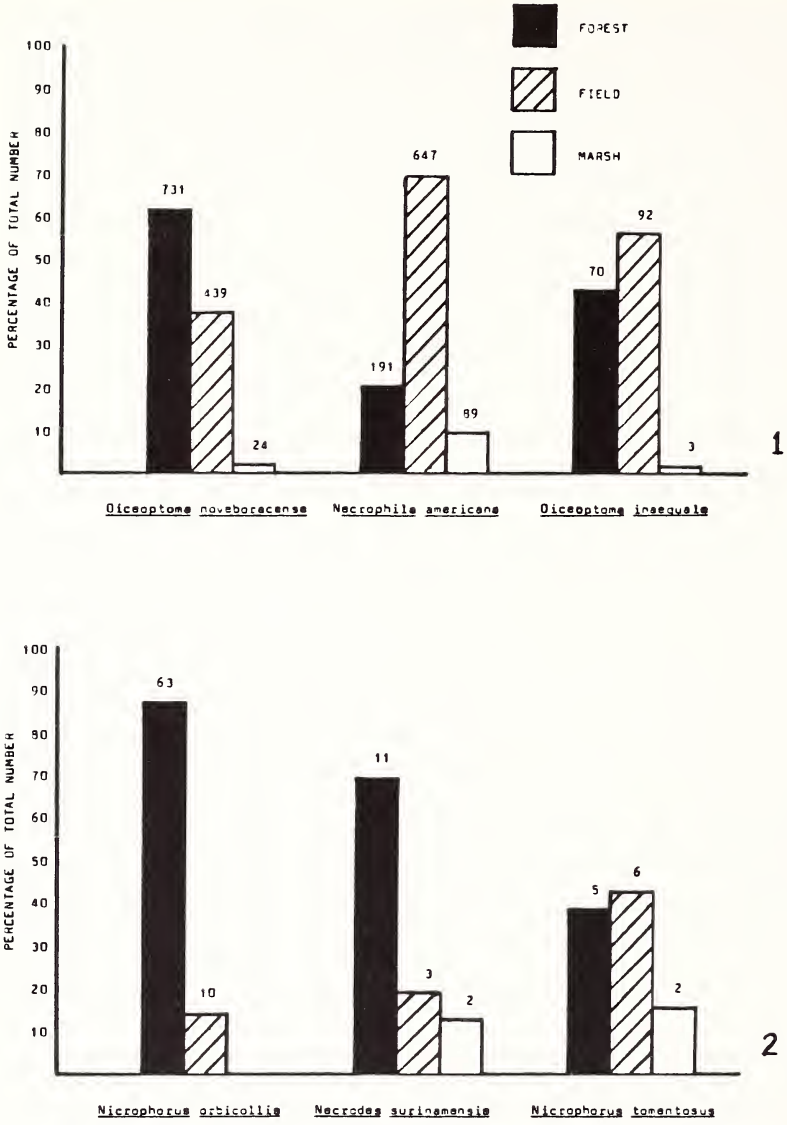
Each of these 3 habitats is located in the management area which is off-limits to visitors. The forest is dominated by red oak (*Quercus rubrum*), but American beech (*Fagus grandifolia*) occurs on its moist fringes. This woodland stand is about 5 hectares in size. The field is about 2 hectares in size and is covered by grasses about 1 meter tall. *Solidago* spp., *Daucus carota,* and *Aster* sp. are also present. The marsh, about 100 hectares in size, contains a variety of hydrophytes including *Pontederia cordata, Typha latifolia, Peltandra virginica,* and *Sagittaria latifolia.*

One of the pair of traps situated in each habitat was baited with fish (smelt), and the second was baited with chicken legs (drumsticks). Carrion bait in each trap consisted of 3 "fresh" fish (about 90 g total weight) and 3 "stale" fish (about 90 g), or 1 "fresh" chicken leg (about 90 g) and one "stale" chicken leg (about 90 g). The fresh and stale components were individually placed into a styrofoam cup (0.258 liter) so that each trap had a cup of fresh carrion and one of stale carrion. These traps were initially baited with "fresh" carrion 1 week before the season's collecting began and on the Saturday that collecting was begun "fresh" carrion was added to the "stale" carrion. Each trap was serviced once per week, throughout the season, at which time the oldest carrion (and cup) was replaced with fresh carrion (and cup), and all beetles were collected and preserved in jars containing 70% alcohol. At all times, therefore, each habitat had one trap baited with fish 1–7 days old (fresh) and fish 8–14 days old (stale), and a second trap baited with a chicken leg 1–7 days old (fresh) and a chicken leg 8–14 days old (stale). This technique (Pirone, 1974) resulted in the presence of fairly uniform "attractive" carrion continuously.

Weekly collections were made from 7 June to 25 August in 1980 and from 3 April to 30 May in 1981. A previous study in GSNWR had shown that carrion beetles were most abundant during the months of April through August (Shubeck et al., 1981).

RESULTS AND DISCUSSION

The catch for both seasons was totaled, by species for each habitat, and the bar graphs in Figures 1 to 4 show the numbers of individuals, and the percentage of the total for the habitat. In order to compare these results with Anderson's results (1982) I had to revise his percentages [Figs. 15–18] after removing his data for the coniferous forest habitat. By doing this I was able to compare results for deciduous forest, field, and marsh habitats in New Jersey and Canada (Table 1). In preparing Walker's data (1957) for comparison it was necessary to average his figures for the 3 deciduous forest habitats [Fig. 7] (mesic forest, bottom forest, ridge forest), and to then work out the percentages for species for deciduous forest versus field for a partial comparison (Table 1).



Figs. 1, 2. Habitat association. 1. *Oiceoptoma noveboracense* (Forster), *Necrophila americana* (L.), *Oiceoptoma inaequale* (F.)—[Silphidae]. 2. *Nicrophorus orbicollis* Say, *Necrodes surinamensis* (F.), *Nicrophorus tomentosus* Weber—[Silphidae].

Oiceoptoma noveboracense was the most abundant species collected (1,149 individuals) and it was common in the forest and in the field but the species preferred the forest habitat (Fig. 1). It was rarely collected in the marsh (2% of total). Anderson (1982) also found this species most common in the

Table 1. A comparison, by percentage, of carrion beetles and their habitat associations in Tennessee, Toronto, Canada, and New Jersey. Percentages rounded off to whole numbers.

	Tennessee		Canada			New Jersey		
	For-est	Field	For-est	Field	Marsh	For-est	Field	Marsh
Oiceoptoma noveboracense (Forster)	—		45	29	26	61	37	2
Necrophila americana (L.)	100	0	21	7	72	20	70	10
Oiceoptoma inaequale (F.)	—		94	0	6	42	56	2
Nicrophorus orbicollis Say	95	5	63	12	25	86	14	0
Necrodes surinamensis (F.)	100	0	0	100	0	69	19	12
Nicrophorus tomentosus Weber	100	0	34	45	21	39	46	15
Nicrophorus pustulatus Herschel	100	0	76	24	0	100	0	0
Nicrophorus marginatus (F.)	—		0	80	20	0	100	0
Dermestes caninus Germ.	9	91	—			44	37	19
Omosita colon (L.)	70	30				57	33	10
Euspilotus assimilis (Payk.)	94	6				43	56	1
Onthophagus hecate Panz.	100	0				9	79	12

deciduous forest and least common in the marsh. Although least common in the marsh 26% of the individuals taken were, in fact, collected in this habitat. It should be noted that Anderson's description of his marsh indicated that it ". . . underwent seasonal inundation, with water accumulating in the spring or after heavy rainfall." It seems clear, therefore, that it was relatively dry part of the time and may have superficially resembled an old field. Walker did not collect this species in his Tennessee study (1957).

Necrophila americana, the second most abundant species (927) collected in GSNWR strongly preferred (70%) the field habitat yet it was somewhat common (20%) in the forest and less common (10%) in the marsh (Fig. 1). Anderson's results were virtually identical for his deciduous forest habitat but he collected 72% of this species in his marsh and 7% in his field (Table 1). If one compares the New Jersey and Canadian data for this species in terms of forest versus field *and* marsh (combined) the results are virtually identical. The Tennessee data are completely different—all of the 162 individuals were collected in the 3 forests and none was taken in the field (Table 1).

Oiceoptoma inaequale, with 165 individuals collected, was the third most abundant silphid species in Great Swamp. Although it slightly preferred the field it was, in fact, common in both forest and field but rarely taken in the marsh (Fig. 1). Anderson found that the bulk (94%) of the individuals collected were taken in the forest, none in the field and 6% in the marsh (Table 1). Walker did not find this species in his study.

The fourth most abundant species in this study was *Nicrophorus orbicollis* and it showed a strong preference for the forest (86%) over the field (14%)

(Fig. 2). Results of the studies in Tennessee and Canada were somewhat similar since Walker collected 95% of his individuals in the forest and 5% in the field, and Anderson took 63% of his individuals in the forest, 12% in the field, and 25% in the marsh (Table 1).

The fifth most abundant silphid species, *Necrodes surinamensis,* was in fact not abundant (Fig. 2). Of the 16 individuals taken, ⅔ were collected in the forest and the remaining ⅓ about equally divided between the field and marsh. Although Walker did not take a single individual in his field, he collected 543 individuals in his deciduous forests (Table 1). Anderson took 7 individuals in his field (Table 1) (plus 4 others in his coniferous forest).

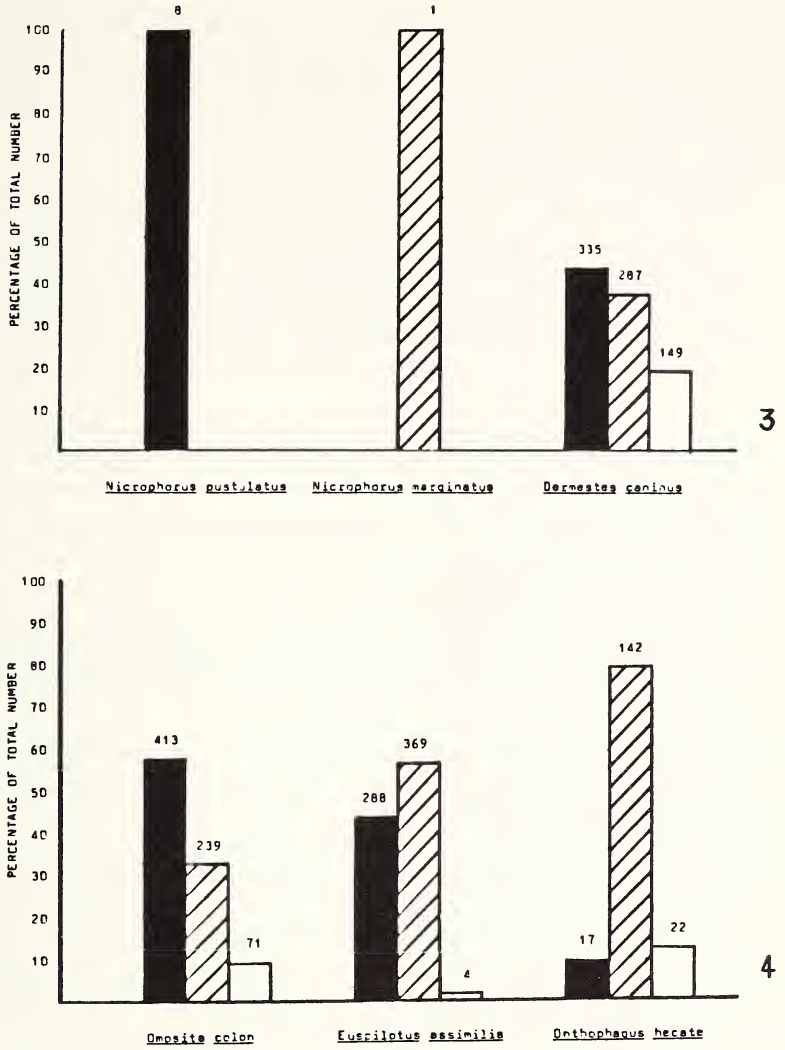
In spite of the fact that only 13 individuals of *Nicrophorus tomentosus* were taken in New Jersey but 1,488 were collected in Anderson's study (1982), a remarkable similarity in the forest : field : marsh percentages was evident (39:46:15 in New Jersey and 34:45:21 in Canada) (Table 1). On the other hand, *all* 51 individuals taken by Walker were collected in the 3 forests. Over 20 years of carrion beetle field studies have made it quite obvious to me that this is the *most active Nicrophorus* species of the 4 I have observed. It is the one that I would expect to have the widest range in its random flight (Shubeck, 1968) as it searches for carrion. This was supported by the data from both the New Jersey and Canadian studies.

Nicrophorus pustulatus, the seventh silphid species in order of abundance numbered but 8 individuals (Fig. 3), all from the forest. Walker's data were also limited to a few individuals (13) and they were all taken in the forest habitats (Table 1). Anderson's data too, were based on a small sample (17) and it indicated a preference of 3:1, forest : field (Table 1). In spite of the small sample in each case the preference of this species for the forest habitat is consistently clear.

The least abundant silphid in GSNWR was *Nicrophorus marginatus* which was limited to 1 individual (Fig. 3). However, it was taken in the open field like Anderson's sample of 125 individuals which showed a preference for the field over the marsh by a 4:1 ratio (Table 1). Although this species was not taken in the Tenneessee study, 1 individual was taken in a field but in no other habitat in Maryland (Shubeck, unpublished data, 1981).

The remaining 4 species are not members of the family Silphidae but they are members of 4 other families which contain species associated with silphid species on carrion. None of these species was included in Anderson's study but they were included in the Tennessee study.

Dermestes caninus (Dermestidae) was the most abundant (771 individuals) non-silphid species collected (Fig. 3). It was common in all 3 habitats but slightly preferred the forest (44%) over the field (37%). A substantial percentage (19%) of individuals was also taken in the marsh. This species is a good flyer and apparently ranges widely in search of dry carrion. The majority of individuals (91%) in Walker's study was collected in the field (Table 1).



Figs. 3, 4. Habitat association. 3. *Nicrophorus pustulatus* Herschel, *Nicrophorus marginatus* (F.)—[Silphidae], and *Dermestes caninus* Germ.—[Dermestidae]. 4. *Omosita colon* (L.)—[Nitidulidae], *Euspilotus assimilis* (Payk.)—[Histeridae], *Onthophagus hecate* Panz.—[Scarabaeidae].

Omosita colon (Nitidulidae) was also taken in large numbers (723). Although this species was present in the marsh (10%) and common in the field (33%), it showed a slight preference for the forest (57%) (Fig. 4). Walker also found in his study that the species preferred the forest to the field in a 7:3 ratio (Table 1).

A total of 661 individuals of the species *Euspilotus assimilis* (Histeridae) was collected in GSNWR. The species was rarely taken in the marsh (less than 1%) and it was common in the forest and field but slightly preferred the latter (Fig. 4). The overwhelming majority (94%) of Walker's specimens in Tennessee was taken in the forest (Table 1).

The last species included in this study is *Onthophagus hecate* (Scarabaeidae). Although it is called a "dung" beetle, it is, in fact, found on dung *and* carrion (Arnett et al., 1980). About $1/10$ of the 181 individuals collected were taken in the forest and a comparable number in the marsh, but the majority (79%) was taken in the field (Fig. 4). All of the individuals of this species collected in Tennessee by Walker were taken in the forest (Table 1).

CONCLUSIONS

Of the 8 silphid species collected in 3 habitats in GSNWR, 5 had a *strong preference* for 1 habitat over the other 2 (more than 60% of the species' representatives were taken in the preferred habitat). These were *Oiceoptoma noveboracense, Necrophila americana, Nicrophorus orbicollis, Nicrophorus pustulatus,* and *Necrodes surinamensis.*

Two silphid species had a *slight preference* for 1 habitat over the other 2 (56% or 46% of the species' representatives were taken in the preferred habitat). These species were *Oiceoptoma inaequale* and *Nicrophorus tomentosus.*

One silphid species manifested a *probable preference* for 1 habitat. *Nicrophorus marginatus,* although limited to 1 specimen was taken in the same habitat (field) in this and 2 other studies.

Insofar as the carrion beetles from other families are concerned 1 species, *Onthophagus hecate* (Scarabaeidae), showed a *strong preference* for 1 habitat (79% of the species' representatives were taken in the preferred habitat). Three species showed a *slight preference* for 1 habitat over the other 2 (44%, 56%, or 57% of the species' representatives were taken in the preferred habitat). These species were *Dermestes caninus* (Dermestidae), *Euspilotus assimilis* (Histeridae), and *Omosita colon* (Nitidulidae).

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